ISO/IEC 23090-3:2026-09 (E)

Information technology - Coded representation of immersive media - Part 3: Versatile video coding

Contents

Page

Foreword viii
Introduction x
1 Scope 1
2 Normative references 1
3 Terms and definitions 1
4 Abbreviated terms 17
5 Conventions 19
5.1 General 20
5.2 Arithmetic operators 20
5.3 Logical operators 20
5.4 Relational operators 21
5.5 Bit-wise operators 21
5.6 Assignment operators 21
5.7 Range notation 22
5.8 Mathematical functions 22
5.9 Order of operation precedence 22
5.10 Variables, syntax elements and tables 23
5.11 Text description of logical operations 24
5.12 Processes 25
6 Bitstream and picture formats, partitionings, scanning processes and neighbouring relationships 26
6.1 Bitstream formats 26
6.2 Source, decoded and output picture formats 26
6.3 Partitioning of pictures, subpictures, slices, tiles, and CTUs 28
6.3.1 Partitioning of pictures into subpictures, slices, and tiles 28
6.3.2 Block, quadtree and multi-type tree structures 31
6.3.3 Spatial or component-wise partitionings 32
6.4 Availability processes 32
6.4.1 Allowed quad split process 32
6.4.2 Allowed binary split process 33
6.4.3 Allowed ternary split process 35
6.4.4 Derivation process for neighbouring block availability 36
6.5 Scanning processes 37
6.5.1 CTB raster scanning, tile scanning, and subpicture scanning processes 37
6.5.2 Up-right diagonal scan order array initialization process 42
6.5.3 Horizontal and vertical traverse scan order array initialization process 42
7 Syntax and semantics 43
7.1 Method of specifying syntax in tabular form 43
7.2 Specification of syntax functions and descriptors 44
7.3 Syntax in tabular form 46
7.3.1 NAL unit syntax 46
7.3.2 Raw byte sequence payloads, trailing bits and byte alignment syntax 47

7.3.2 Raw byte sequence payloads, trailing bits and byte alignment syntax 47
7.3.3 Profile, tier, and level syntax 67
7.3.4 DPB parameters syntax 70
7.3.5 Timing and HRD parameters syntax 70
7.3.6 Supplemental enhancement information message syntax 72
7.3.7 Slice header syntax 72
7.3.8 Weighted prediction parameters syntax 75
7.3.9 Reference picture lists syntax 76
7.3.10 Reference picture list structure syntax 76
7.3.11 Slice data syntax 77
7.4 Semantics 101
7.4.1 General 101
7.4.2 NAL unit semantics 101
7.4.3 Raw byte sequence payloads, trailing bits and byte alignment semantics 110
7.4.4 Profile, tier, and level semantics 171
7.4.5 DPB parameters semantics 177
7.4.6 Timing and HRD parameters semantics 178
7.4.7 Supplemental enhancement information message semantics 183
7.4.8 Slice header semantics 183
7.4.9 Weighted prediction parameters semantics 194
7.4.10 Reference picture lists semantics 195
7.4.11 Reference picture list structure semantics 197
7.4.12 Slice data semantics 198
Decoding process 226
8.1 General decoding process 226
8.2 NAL unit decoding process 229
8.3 Slice decoding process 229
8.3.1 Decoding process for picture order count 229
8.3.2 Decoding process for reference picture lists construction 231
8.3.3 Decoding process for reference picture marking 237
8.3.4 Decoding process for generating unavailable reference pictures 238
8.3.5 Decoding process for symmetric motion vector difference reference indices 238
8.3.6 Decoding process for collocated picture and no backward prediction 239
8.4 Decoding process for coding units coded in intra prediction mode 240
8.4.1 General decoding process for coding units coded in intra prediction mode 240
8.4.2 Derivation process for luma intra prediction mode 242
8.4.3 Derivation process for chroma intra prediction mode 245
8.4.4 Cross-component chroma intra prediction mode checking process 247
8.4.5 Decoding process for intra blocks 248
8.5 Decoding process for coding units coded in inter prediction mode 285
8.5.1 General decoding process for coding units coded in inter prediction mode 285
8.5.2 Derivation process for motion vector components and reference indices 290
8.5.3 Decoder-side motion vector refinement process 314
8.5.4 Derivation process for geometric partitioning mode motion vector components and reference indices 320
8.5.5 Derivation process for subblock motion vector components and reference indices 322
8.5.6 Decoding process for inter blocks 352
8.5.7 Decoding process for geometric partitioning mode inter blocks 379
8.5.8 Decoding process for the residual signal of coding blocks coded in inter prediction mode 385

8.5.9 Decoding process for the reconstructed signal of chroma coding blocks coded in inter prediction mode 387
8.6 Decoding process for coding units coded in IBC prediction mode 389
8.6.1 General decoding process for coding units coded in IBC prediction mode 389
8.6.2 Derivation process for block vector components for IBC blocks 391
8.6.3 Decoding process for IBC blocks 396
8.7 Scaling, transformation and array construction process 397
8.7.1 Derivation process for quantization parameters 397
8.7.2 Scaling and transformation process 399
8.7.3 Scaling process for transform coefficients 400
8.7.4 Transformation process for scaled transform coefficients 403
8.7.5 Picture reconstruction process 424
8.8 In-loop filter process 428
8.8.1 General 428
8.8.2 Picture inverse mapping process for luma samples 429
8.8.3 Deblocking filter process 430
8.8.4 Sample adaptive offset process 462
8.8.5 Adaptive loop filter process 465
9 Parsing process 478
9.1 General 478
9.2 Parsing process for k-th order Exp-Golomb codes 479
9.2.1 General 479
9.2.2 Mapping process for signed Exp-Golomb codes 480
9.3 CABAC parsing process for slice data 480
9.3.1 General 480
9.3.2 Initialization process 482
9.3.3 Binarization process 507
9.3.4 Decoding process flow 518
Annex A (normative) Profiles, tiers and levels 537
A.1 Overview of profiles, tiers and levels 537
A.2 Requirements on video decoder capability 537
A.3 Profiles 538
A.3.1 Main 10 and Main 10 Still Picture profiles 538
A.3.2 Main 10 4:4:4 and Main 10 4:4:4 Still Picture profiles 539
A.3.3 Multilayer Main 10 profile 540
A.3.4 Multilayer Main 10 4:4:4 profile 540
A.3.5 Operation range extensions profiles 540
A.4 Tiers and levels 544
A.4.1 General tier and level limits 544
A.4.2 Profile-specific level limits 546
A.4.3 Effect of level limits on picture rate 550
Annex B (normative) Byte stream format 558
B.1 General 558
Annex C (normative) Hypothetical reference decoder 561
C.1 General 561
C.2 Operation of the CPB 567
C.2.1 General 567
C.2.2 Timing of DU arrival 567

C.2.3 Timing of DU removal and decoding of DU 570
C.3 Operation of the DPB 573
C.3.1 General 573
C.3.2 Removal of pictures from the DPB before decoding of the current picture 573
C.3.3 Picture output 574
C.3.4 Current decoded picture marking and storage 575
C.4 Bitstream conformance 575
C.5 Decoder conformance 577
C.5.1 General 577
C.5.2 Operation of the output order DPB 578
C.5.2.1 General 578
C.5.2.2 Output and removal of pictures from the DPB 579
C.5.2.3 Additional bumping 580
C.5.2.4 "Bumping" process 580
C.6 General sub-bitstream extraction process 580
C.7 Subpicture sub-bitstream extraction process 582
Annex D (normative) Supplemental enhancement information and use of SEI and VUI 588
D.1 General 588
D.2 General SEI payload 588
D.2.1 General SEI payload syntax 588
D.2.2 General SEI payload semantics 591
D.3 Buffering period SEI message 595
D.3.1 Buffering period SEI message syntax 595
D.3.2 Buffering period SEI message semantics 596
D.4 Picture timing SEI message 601
D.4.1 Picture timing SEI message syntax 601
D.4.2 Picture timing SEI message semantics 602
D.5 DU information SEI message 607
D.5.1 DU information SEI message syntax 607
D.5.2 DU information SEI message semantics 608
D.6 Scalable nesting SEI message 609
D.6.1 Scalable nesting SEI message syntax 609
D.6.2 Scalable nesting SEI message semantics 610
D.7 Subpicture level information SEI message 612
D.7.1 Subpicture level information SEI message syntax 612
D.7.2 Subpicture level information SEI message semantics 613
D.8 SEI manifest SEI message 616
D.8.1 SEI manifest SEI message syntax 616
D.8.2 SEI manifest SEI message semantics 617
D.9 SEI prefix indication SEI message 618
D.9.1 SEI prefix indication SEI message syntax 618
D.9.2 SEI prefix indication SEI message semantics 619
D.10 Constrained RASL encoding indication SEI message 620
D.10.1 Constrained RASL encoding indication SEI message syntax 620
D.10.2 Constrained RASL encoding indication SEI message semantics 620
D.11 Use of ITU-T H.274 | ISO/IEC 23002-7 VUI parameters 621
D.12 Use of SEI messages specified in other documents 621
D.12.1 General 621

D.12.2 Use of the film grain characteristics SEI message 622
D.12.3 Use of the decoded picture hash SEI message 622
D.12.4 Use of the dependent random access point (DRAP) indication SEI message 623
D.12.5 Use of the equirectangular projection, generalized cubemap projection, and region-wise packing SEI messages 623
D.12.6 Use of the frame-field information SEI message 623
D.12.7 Use of the annotated regions SEI message 624
D.12.8 Use of the extended dependent random access point (EDRAP) indication SEI message 624
D.12.9 Use of the colour transform information SEI message 624
D.12.10 Use of the shutter interval information SEI message 624
D.12.11 Use of the neural network post-filter characteristics SEI message and the neural network post-filter activation SEI message 624
D.12.12 Use of the phase indication SEI message 628
D.12.13 Use of the SEI processing order and processing order nesting SEI messages 628
D.12.14 Use of the encoder optimization information SEI messages 629
D.12.15 Use of the source picture timing SEI message 629
D.12.16 Use of the object mask information SEI message 629
D.12.17 Use of the digitally signed content initialization, digitally signed content selection, and digitally signed content verification SEI messages 630
D.12.18 Use of the generative face video SEI message 630
D.12.19 Use of the generative enhancement face video SEI message 630
D.12.20 Use of the packed regions information SEI message 631
Bibliography 632